Claims:

What is claimed is:

1. A photomultiplier tube, comprising:

a light source;

a photocathode positioned to receive the optical photons from the light source and emit a corresponding photoelectron; and

an amplifier positioned to receive the photoelectron from the photocathode and emit a corresponding electron pulse;

wherein the photocathode includes a substantially flat first surface disposed towards the light source;

wherein the photocathode includes a substantially large aspect-ratio second surface disposed toward the amplifier; and

wherein the substantially large aspect-ratio surface includes a plurality of substantially conical structures at least partially composed of a photoelectric converting material.

2. The system of claim 1 wherein the plurality of substantially conical structures has average aspect ratios in excess of about 3:1.

3. The system of claim 1 wherein the plurality of substantially needle-shaped structures has average aspect ratios in excess of about 10:1.

4. The system of claim 1 wherein the plurality of substantially needle-shaped structures has average aspect ratios in excess of about 50:1.

5. The system of claim 1 wherein the plurality of substantially needle-shaped structures has an average aspect ratio in excess of about 100:1.

6. The system of claim 1 wherein the photoelectric converting material is selected from the group consisting of alkali metals.

7. The system of claim 1 wherein the photoelectric converting material is selected from the group consisting of alkali metals in concert with cesium.

8. The system of claim 1 wherein the photoelectric converting material is selected from the group consisting of column III-V compounds.

9. The system of claim 1 wherein the photoelectric converting material is selected from the group consisting of column III-V compounds in concert with cesium.

10. The system of claim 1 wherein the photoelectric converting material is selected from the group consisting of silicon carbide, amorphous diamond-like carbon, diamond, carbon nanotubes, and quantum dots.

11. A photoelectron emitting device comprising:

a substrate having at least one major side;

a large aspect-ratio structure extending from the at least one major side; and

a photocathode formed on the at least one major side;

wherein the photocathode is formed of a photoelectric converting material; and

wherein the large aspect ratio structures are at least partially made of the photoelectric converting material.

12. A photoelectron emitting device comprising:

a substrate having a major side and a plurality of large aspect-ratio structures extending from the major side; and

a photocathode made of a photoelectric converting material and formed on the one major side of the substrate;

wherein the large aspect-ratio structures have an average aspect ratio of at least about 3:1; and

wherein the large aspect ratio structures are at least partially made of the photoelectric converting material.

13. The device of claim 12 wherein the large aspect-ratio structures have an average aspect ratio of at least about 10:1

14. The device of claim 12 wherein the large aspect-ratio structures have an average aspect ratio of at least about 50:1

15. The device of claim 12 wherein the large aspect-ratio structures have an average aspect ratio of at least about 100:1

16. The device of claim 12 wherein large aspect-ratio structures are substantially composed of the photoelectric converting material and wherein the large aspect ratio structures are deposited onto the substrate.

17. The device of claim 12 wherein the substrate is substantially transparent.

18. The device of claim 12 wherein the photoelectric converting material is selected from the group consisting of alkali metals.

19. The device of claim 12 wherein the photoelectric converting material is selected from the group consisting of alkali metals in concert with cesium.

20. The device of claim 12 wherein the photoelectric converting material is selected from the group consisting of column III-V compounds.

21. The device of claim 12 wherein the photoelectric converting material is selected from the group consisting of column III-V compounds in concert with cesium.

22. The device of claim 12 wherein the photoelectric converting material is selected from the group consisting of silicon carbide, amorphous diamond-like carbon, and diamond, carbon nanotubes, and quantum dots.

23. The device of claim 12 wherein the large aspect ratio structures have an average length of about 3 microns.

24. A method for producing a photocathode having an increased surface area to volume ratio, comprising the steps of:

a. providing a substantially flat substrate;

b. depositing photoemissive material onto the substrate at a rate sufficiently high such that film growth is naturally large aspect ratio in nature.

25. The method of claim 24 wherein the photoemissive material is deposited by at least one of the following techniques: sputtering, evaporating, electrodeposition, soot deposition, aerogel coating, electrostatic coating, Langmuir-Blodgett filmography, solution dipping, and spin coating.

26. The method of claim 24 further comprising the steps of:

c. heat treating the photoemissive material; and

d. patterning a large aspect-ratio structure onto the photocathode.

27. The method of claim 26 wherein the large aspect-ratio structure is patterned by at least one of the following techniques: spraying, ion milling, photolithography, immersion, chemical vapor deposition, physical bombardment, and etching.

28. A method for producing a photocathode having an increased surface area to volume ratio, comprising the steps of:

a. providing a web structure formed of web fibers having diameters smaller than the escape distance of a photoelectron and having large open areas relative to the diameter of the web fibers; and

b. depositing photoemissive material onto the web structure.

29. The method of claim 28 further comprising the step of heat treating the photoemissive material.

30. The method of claim 28 further comprising the step of mounting the web-reinforced photocathode in a photomultiplier tube such that light falls uniformly on this photocathode and photoelectrons emerging from both sides are equally probable to enter multiplication stages.

31. The method of claim 30 wherein light is launched into the photocathode and is guided within the photocathode by total internal reflection.

32. The method of claim 28 further comprising the step of densifying the photoemissive material.

33. The method of claim 28 wherein the photoemissive material is a transparent polymer or glass.

34. A method for producing a photomultiplier tube having increased quantum efficiency, comprising the steps of:

a. providing a windowed tube;

b. providing a substantially flat substrate;

c. depositing photoemissive material onto the substrate at a rate sufficiently high such that film growth is naturally large aspect-ratio in nature

d. affixing the substrate to the window.

35. A method for producing a photomultiplier tube having increased quantum efficiency comprising the steps of:

a. providing a windowed tube;

b. providing a substantially flat substrate;

c. patterning a large aspect-ratio structure onto the photocathode by photolithography, ion milling, or other means;

d. heat treating the photoemissive material to create a dense surface;

e. affixing the substrate to the window.

36. A method for producing a photomultiplier tube having an increased surface area to volume ratio, comprising the steps of:

a. providing a web structure formed of web fibers having diameters smaller than the escape distance of a photoelectron and having large open areas relative to the diameter of the web fibers;

b. depositing transparent nonconductive material onto the web structure;

c. depositing photoemissive material onto the transparent nonconducting material;

d. densifying the photoemissive material;

e. providing a windowed tube;

f. mounting the web structure in the tube.

37. The method of claim 36 wherein in light is launched into the photocathode and guided therein by total internal reflection and wherein photoelectrons emerging from both sides are equally probable to enter multiplication stages.